The Role of Energy Efficiency

The U.S. manufacturing sector depends heavily on energy resources to provide fuel and power for the conversion of raw materials into usable products. How efficiently energy is used, as well as the cost and availability of energy, consequently have a substantial impact on the competitiveness and economic health of U.S. manufacturers. More efficient use of energy lowers production costs, conserves limited energy resources, and increases productivity. The more efficient use of energy also has positive impacts on the environment – reductions in fuel use translate directly into fewer emissions of criteria pollutants such as sulfur oxides, nitrogen oxides, and particulates, as well as greenhouse gases such as carbon dioxide.

Energy efficiency can essentially be defined as the effectiveness with which energy resources are converted into usable work. Thermal efficiency is commonly used to measure the efficiency of energy conversion systems such as process heaters, steam systems, engines, and power generators. While there are many ways to determine thermal efficiency, it is basically the measure of the efficiency and completeness of fuel combustion, or in more technical terms, the ratio of the net work supplied to the heat supplied by the combusted fuel. In a gas-fired heater, for example, thermal efficiency would be equal to the total heat absorbed divided by the total heat supplied; in an automotive engine, thermal efficiency would be the work done by the gases in the cylinder divided by the heat energy of the fuel supplied.

Energy efficiency varies dramatically across industries and manufacturing processes, and even between plants manufacturing the same products. Efficiency can be limited by mechanical, chemical, or other physical parameters, or by the age and design of equipment. In some cases, operating and maintenance practices contribute to lower than optimum efficiency. Regardless of the reason, less than optimum energy efficiency means that as equipment is used, not all of the energy is converted to useful work – some is released as lost energy. In the manufacturing sector, these energy losses amount to several quadrillion Btus (British Thermal Units) and billions of dollars in lost revenues every year.

Typical Thermal Efficiencies of Selected Energy Systems and Industrial Equipment

Power Generation	25-44%
Steam Boilers (natural gas)	80%
Steam Boilers (coal and oil)	84-85%
Water Heat Boilers	70%
Compressors	10-20%
Pumps and Fans	55-65%
Motors	90-95%

Given this resource and cost perspective, it is clear that increasing the efficiency of energy use could result in substantial benefits to both industry and the nation. Unfortunately, the sheer complexity of the thousands of processes used in the manufacturing sector makes this a daunting task. There are, however, significant opportunities to address energy efficiency in generic energy systems that are used across many different industries, such as steam generators, onsite power systems, fired heaters, heat exchangers, compressors, motors, pumps, and others. A first step in realizing these opportunities is to identify where and how industry is using energy – how much is used for various energy systems, how much is lost, how much goes directly to processes, and so forth. Answering these questions for the U.S. manufacturing and mining sectors is the focus of the energy use and loss analysis.